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Recording and erasing system for thermoreversible recording medium

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Abstract:

Abstract of **EP0729848**

A recording and erasing system uses a thermoreversible medium 1, which is heated to a first temperature so as to make an image visible thereon, and is heated to a second temperature so as to make the image invisible. Such a thermoreversible recording medium tends to carry residual images thereon when its thermoreversibility is reduced after repeated recording and erasing processes. To overcome such a problem, the recording and erasing system includes an erasing data generating means 7 for varying the energy applied to a heating means so that the recording medium can be heated to a predetermined temperature. The recording and erasing system has a means for checking the usability of the recording medium, thereby preventing use of unusable recording mediums.

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Domestic Patent References:

EP0461606A Rewriteable recording/display apparatus and method of erasing record.

EP0468237A Method of and apparatus for rewritable recording and erasing and rewritable recording film.

Foreign References:

4851924 Color recorder overhead projector with color recorder

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Claims:

1. A recording and erasing system for repeatedly recording and erasing an image on a thermoreversible recording medium (64) by applying a predetermined quantity of energy to desired areas thereof via a heating means (63), the recording and erasing system comprising a background pattern generating means (67) for generating a background pattern on a specified area of said recording medium, an external data input means (61) for inputting image data to be recorded, a recording control means (62) for controlling said heating means and switching means (66) for selectively connecting said external data input means and said background pattern generating means to said recording control means wherein the erasing is performed after the background pattern is recorded on the recording medium.

Description:

This invention relates to a recording and erasing system which records an image on a thermoreversible recording medium and erases such a recorded image therefrom by controlling a quantity of energy applied thereto.

EP 0 461 606 A2 and EP 0 468 237 A2 refer to a recording and erasing system for repeatedly recording and erasing an image on and from a thermoreversible medium by applying a predetermined quantity of energy to desired areas of said medium via a heating means. Said systems comprise energy varying means so as to erase an image on the recording medium. The heating means applies a first quantity of energy to areas where an image is to be erased and a second quantity of energy to areas where an image is to be formed.

Up to now, efforts have been made to develop recording systems which can repeatedly record and erase an image on and from a thermoreversible recording medium which becomes black, or transparent and colorless depending upon quantities of thermal energy applied thereto.

Japanese patent laid-open publications No. Sho 57-77140 and Hei 2-188294 propose examples of thermographic materials for such a recording medium.

The former publication exemplifies a thermoreversible recording medium comprising layers of thermoreversible material of a whitening group applied on the surface of a glass or plastic substrate. This material inserts its state at two transition temperatures t_1 and t_2 ($t_1 < t_2$). When heated above the temperature t_2 for a given period of time, the material becomes white. On the other hand, when heated above t_1 but below t_2 for a second given period of time, the material becomes transparent and colorless. Therefore, heating elements of a thermal head associated with an image to be recorded are heated above t_2 , while heating elements associated with an image to be erased are heated above t_1 but under t_2 .

The latter publication discloses a thermoreversible medium including a thermoreversible material of a dye group. When the recording medium contains a dye whose transparency or color changes with temperatures, the medium can be repeatedly used for recording and erasing images such as letters and

symbols thereon and therefrom, respectively, similarly to the foregoing thermoreversible medium of the whitening group.

The principle of the recording system will be described hereinafter. When a first energy (h_1) is applied from a dynamic heat source such as a thermal head, the thermoreversible material is developed to form a first dark image (in black). The image is maintained as it is in a normal environment (temperature and humidity), but is erasable when a second energy (h_2) is applied thereto. When the first energy (h_1) is applied again, a second image can be formed. Thus, the recording and erasing can be performed repeatedly.

Fig. 1 of the accompanying drawings is a schematic view showing the configuration of the foregoing recording medium 1, which comprises a protective film 14, a recording layer 15 including materials such as a dye, an agent for making an image visible/invisible and a binder, and a substrate 16. When the first large energy (h_1) of 200 to 300°C is applied onto the recording medium 1 for a short period of time, e.g. 1 to 3 ms, in the direction shown by an arrow A, a black image is formed on the recording medium 1, for example. Conversely, when the second small energy (h_2) of 80 - 160°C is applied to the recording medium 1 for a relatively long period of time, e.g. 5 ms to 2 sec, in the direction of the arrow A, the image is erased from the recording medium.

Specifically, the recording layer 15 includes an agent for making the image visible/invisible which becomes acid and salt in response to an applied energy, and a leuco dye whose color changes with variations of acidity. Fig. 2 shows phenyl carbonate and organic amine salt as an example of the agent for making the image visible/invisible. Fig. 3 (a) shows a colorless leuco compound and Fig. 3 (b) shows a colored leuco compound.

The agent for making the image visible/invisible becomes acid when it is heated above the temperature t_2 , so that lactone rings of the leuco dye are opened. Thus, the leuco dye becomes colored. When heated above the temperature t_1 but under the temperature t_2 , the agent for making the image visible/invisible changes to alkaline, so that the opened lactone rings are closed. Therefore, the leuco dye becomes colorless.

This recording medium has characteristics as shown in Figs. 4 and 5. In Fig. 4, the abscissa represents a period of time for voltage supply, and the ordinate represents a recording density. From Fig. 4, it can be seen that the recording medium has the maximum recording density of 1.2 when the recording medium is applied with a voltage for approximately 3 ms. In Fig. 5, the abscissa denotes an erasing temperature and the ordinate a recording density after erasure. In this case, the recording medium is applied with the voltage for 3 ms (i.e. the state where the recording medium has a recording density of 1.2) and is then heated by a heat roller, a thermal head or the like. Fig. 5 shows that the recording medium is completely free from an image near 120°C to 150°C (i.e. the state where the recording medium is similar to that having the density 0.15 prior to the recording).

The erasing characteristics are also shown in Figs. 6 and 7, which are obtained in a different manner. Fig. 6 shows a completely black pattern 41 formed by the thermal head on the recording medium 1. Fig. 7 shows the erasing characteristic of the recording system which erases the black pattern of Fig. 6. An energy of 1.0 mJ/dot and an energy of 0.6 mJ/dot are applied to the recording medium in the direction shown by an arrow B for the recording and erasing, respectively. Referring to Fig. 7, it can be seen that the erasing is not complete at the beginning of the erasing process (i.e. about the first to 30th lines in the black image) and substantially after the 300th and succeeding lines of the black image.

The head portion of the recorded image is not erased because the thermal head does not reach its effective temperature. This is because heating elements of the thermal head take a certain period of time

to become effective even when thermal head is left at room temperature (without applying a voltage thereto for a while) and is heated under such a condition. The thermal head is not elevated to its effective temperature until the tenth line is being erased. In other words, the thermal head is unstable in its operation until it is sufficiently activated.

The reason why the image is not erased in a portion following a 300th line is that the heating elements become too hot in the heated thermal head. Two kinds of energy are reserved in the thermal head. One is a part of the energy generated by the heating elements and the other is the energy which is used to erase a previous line and both energies remain accumulated around the heating elements. Both of these energies raise the temperature of the heating elements which are repeatedly heated for every line. Thus, the thermal head becomes too hot to erase the recorded image.

Fig. 8 shows a comparison of erasing characteristics on a large recording medium of A4 size and a small recording medium of a card size. In Fig. 8, the ordinate represents the numerical order of a line to be erased, and the abscissa represents an erasing temperature. The larger the recording medium, the more incomplete the erasure.

The conventional recording and erasing system for the thermoreversible recording medium adopts a method in which energies are applied to the recorded image so as to make it invisible. In other words, the recorded image to be erased is heated at the temperature which is above t_1 but under t_2 as mentioned above.

As described so far, the thermoreversible recording medium tends to vary its reflectance and recording density somewhat depending upon its recording and erasing history. In other words, the recording medium shows different degrees of reflectance and recording densities at the recorded and erased areas and at the areas which have never been recorded and erased. Therefore, incompletely erased images sometimes remain vaguely on the recording medium in a manner such that they are faintly visible. Prior art recording and erasing systems suffer from the problem that erasure is somewhat incomplete.

Furthermore, there are few recording mediums which are completely thermoreversible. Usually, the more often they are used, the poorer they become, and finally they will become unusable. During repeated use, the recording medium extensively undergoes physical and chemical changes so that it may become worn out. Furthermore, the recording medium may have its protective film and thermoreversible film damaged by heat and pressure applied thereto via the thermal head as a heating means. Therefore, the user has to determine whether or not the recording medium in use is still usable, and remove the unusable recording medium. If such a unusable recording medium is continuously used since the user is not aware of its reduced performance, either recording or erasing cannot be carried out thereon, which will be inconvenient to the user.

Such determination on the performance of the recording medium will be troublesome to the user. Sometimes, the user might throw away a still usable recording medium, or recording might be performed to no avail on an unusable recording medium.

This invention is intended to overcome the foregoing Problems encountered with prior art systems. It is an object of the invention to provide a recording and erasing system which can erase a previous image from a recording medium so that it is remarkably indistinct, and which can identify a used-up recording medium.

This object is achieved by a system having the features mentioned in claim 1.

The principles of the present invention are shown Figs. 1 to 8.

- Fig. 1 shows the configuration of a thermoreversible recording medium 1 in film shape.
- Fig. 2 shows the structure of an agent for making an image visible/invisible constituting the

thermoreversible recording medium.

- Fig. 3 shows the structure of dye used for the recording medium.
- Fig. 4 is a graph showing the relationship between a recording density and a voltage-supplying period.
- Fig. 5 is a graph similar to Fig. 4.
- Fig. 6 shows an area to be heated for recording and erasing processes on the recording medium.
- Fig. 7 is a graph showing recording densities of respective lines after the erasing process.
- Fig. 8 is a graph showing recording densities of respective erased lines.
- Fig. 9 is a schematic view of a recording and erasing system according to an embodiment of the present invention.
- Fig. 10 shows the configuration of a recording and erasing system according to another embodiment.

The invention will be described hereinafter with reference to a preferred embodiment shown in the drawing figures.

The recording and erasing system of the invention has the structure as shown in Fig. 9. The recording and erasing system is applicable to devices such as an information display, an electronic board and a message board used in a railway station. A thermoreversible recording medium 1 is repeatedly used for the recording and erasing processes, and is in the shape of a film in this embodiment. The recording medium 1 extends around supports 2 and 4 in a manner such that one image area thereof is visible in the direction shown by an arrow C. The supports 2 and 4 are made of material like rubber, and are rotated either clockwise or counterclockwise by a drive source such as a motor, not shown. A heating means 3 comes into contact with the support 2 so as to heat the recording medium 1, thereby perform the recording or erasing thereon. The heating means 3 comprises a thermal head, and has a size substantially equal to the width of the recording medium 1. For instance, when a visible area of the recording medium 1 is approximately of A4 size, the heating means 3 includes approximately 2,500 heating elements (not shown). A control means 62 controls the recording and erasing operations.

In operation, the recording and erasing system records an image based on data which are read by a word processor, a scanner or the like, and are transferred to the control means 62.

The invention relates to a device for obscuring a residual image which is left on the recording medium when the dye in the recording layer is not completely reversible.

Referring to Fig. 12, an image is input from an external data input unit 61 such as a keyboard. A recording control unit 62 controls a heating unit 63 for heating the heating elements associated with an image to be recorded. In this case, the recording medium 64 is heated above the temperature t_2 (called "high-temperature heating"), and develops the image at the heated portions thereof. As the recording medium 64 is fed by the roller 65, the heating unit 63 heats heating elements according to the image to be recorded, under control of the recording control unit 62, so that the image is recorded on the recording medium.

To erase the recorded image, a background pattern of the image is recorded first of all. Then, the erasing process will be initiated.

The background pattern comprises characters, symbols and so on, which preferably makes the main images unidentifiable.

First of all, a switch 66 is operated to connect a background pattern generating unit 67 to the recording control unit 62, which controls the heating unit 63 according to the background pattern. The heating unit 63 performs the high-temperature heating so as to record the background pattern over the entire area of the recording medium 64 which is fed by a roller 5. Thus, the main image which is already present on the recording medium is merged into the background pattern and becomes indistinct. This is because the background patterns has substantially the same color and density as the main image.

Then, the heating unit 63 heats the whole area of the recording medium 64 to the temperature higher than t_1 but below t_2 (called "low temperature heating"). Both the main image and the background pattern undergo the erasing process. The main image and the background patterns are not always erased completely, and may be vaguely left on the recording medium as mentioned above. Thus, the residual background pattern makes the main image indistinct. Therefore, when

The recording medium of the present invention is applicable as a parking card, a prepaid card, a commuter ticket and so forth. Repeated use of such cards is very effective in the conservation of natural resources. Further, contents of previous recording will not be revealed when the recording medium is reused.

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